

IN THE CLAIMS

1. (currently amended) An acid copper electroplating composition comprising an aqueous solution of an acid and a copper salt, the improvement comprising the addition of at least one of a carrier compound; a water-soluble, mercapto-containing organic brightener compound; and a leveler compound which comprises an organic compound containing single or multiply positively charged centers; wherein said organic compound is selected from the group consisting of polyethylenimine, 80% ethoxylated; poly(allylamine); poly(allylamine hydrochloride); polyaniline, sulfonated, 5 wt. % in water, 75 mole % sulfonated; poly[bis(2-chloroethyl)ether-alt-1,3-bis[3-(dimethylamino)propyl]urea, quaternized; poly[N,N'-bis(2,2,6,6-tetramethyl-4-piperidinyl)-1,6-hexanediamine-co-2,4-dichloro-6-morpholino-1,3,5-triazine; polyacrylamide; poly(acrylamide-co-diallyldimethylammonium chloride); poly(diallyldimethylammonium chloride); poly(melamine-co-formaldehyde), partially methylated; poly(4-vinylpyridine), 25% cross-linked; and poly(1,2-dihydro-2,2,4-trimethylquinoline).
2. (previously presented) The composition as claimed in claim 1 wherein said acid is sulfuric acid.
3. (previously presented) The composition as claimed in claim 1 wherein said copper salt is selected from the group consisting of copper sulfate, copper acetate, copper fluoborate, cupric nitrate and copper pyrophosphate.
4. (previously presented) The composition as claimed in claim 3 wherein said copper salt is copper sulfate.
5. (previously presented) The composition as claimed in claim 1 wherein said carrier compound is selected from the group consisting of a polysaccharide compound, polyethylene glycol and poly(ethylene oxide).
6. (previously presented) The composition as claimed in claim 5 wherein said polysaccharide carrier is selected from the group consisting of starch, cellulose, amylopectin and amylose.

7. (previously presented) The composition as claimed in claim 1 wherein said water-soluble, mercapto-containing organic brightener is selected from the group consisting of *N*-methylallyl-*N'*-methylthiourea; tetramethylthiuram disulfide; ethylethylthiomethyl sulfoxide; ammonium diethyldithiocarbamate; dimethyl-2-thioxo-1,3-dithiole-4,5-dicarboxylate; 3-mercaptopropanesulfonic acid sodium salt; 3-mercaptopropanesulfonic acid; bis (2-mercaptoproethyl) sulfide; ethylene trithio carbonate; ethanethiol; 2-mercaproethanol; monothioglycerol (1-thioglycerol); 1,2-ethanedithiol; and thiодиethanol.

8. (previously presented) The composition as claimed in claim 7 wherein said water-soluble, mercapto-containing organic brightener is selected from the group consisting of ammonium diethyldithiocarbamate, 3-mercaptopropanesulfonic acid sodium salt, and 3-mercaptopropanesulfonic acid.

11. (currently amended) The composition as claimed in claim 4-7 wherein said organic compound is selected from the group consisting of poly[(bis(2-chloroethyl)ether-alt-1,2-bis[3-(dimethylamino)propyl]urea, quaternized, and poly(diallyl dimethylammonium chloride).

16. (previously presented) The composition as claimed in claim 1 further comprising a brightener/carrier molecule.

17. (previously presented) The composition as claimed in claim 16 wherein said brightener/carrier molecule is polymeric protein.

18. (previously presented) The composition as claimed in claim 1 further comprising a carrier/leveler molecule.

19. (previously presented) The composition as claimed in claim 18 wherein said carrier/leveler molecule is selected from the group consisting of poly[bis(2-chloroethyl)ether-alt-1,3-bis[3-(dimethylamino)propyl] urea, quaternized, and poly(melamine-co-formaldehyde).

20. (previously presented) The composition as claimed in claim 1 wherein the weight ratio of carrier to leveler to brightener ranges from about 0.09 to 47.6 : 0.09 to 47.6 : 0.2 to 4.7 weight/weight percent.

21. (currently amended) An improved method for making an acid copper electroplating bath comprising an aqueous solution of acid and copper salt, the improvement comprising adding to said bath a carrier compound; a water-soluble, mercapto-containing organic brightener compound; and a leveler compound which comprises an organic compound containing single or multiply positively charged centers; wherein said organic compound is selected from the group consisting of ~~polyethylenimine, 80% ethoxylated~~; poly (allylamine); poly (allylamine hydrochloride); polyaniline, sulfonated, 5 wt. % in water, 75 mole % sulfonated; poly[bis (2-chloroethyl)ether-alt-1,3-bis[3-(dimethylamino)propyl]urea, quaternized; poly[N,N'-bis(2,2,6,6-tetramethyl-4-piperidinyl)-1,6-hexanediamine-co-2,4-dichloro-6-morpholino-1,3,5-triazine; polyacrylamide; poly(acrylamide-co-diallyldimethylammonium chloride); poly(diallyldimethylammonium chloride); poly(melamine-co-formaldehyde), partially methylated; poly(4-vinylpyridine), 25% cross-linked; and poly(1,2-dihydro-2,2,4-trimethylquinoline).

22. (previously presented) The method as claimed in claim 21 wherein said carrier compound is selected from the group consisting of a polysaccharide compound, polyethylene glycol and poly(ethylene oxide).

23. (previously presented) The method as claimed in claim 22 wherein said polysaccharide carrier is selected from the group consisting of starch, cellulose, amylopectin and amylose.

24. (previously presented) The method as claimed in claim 21 wherein said water-soluble, mercapto-containing organic brightener is selected from the group consisting of *N*-methylallyl-*N*-methylthiourea; tetramethylthiuram disulfide; ethylethylthiomethyl sulfoxide; ammonium diethyldithiocarbamate; dimethyl-2-thioxo-1,3-dithiole-4,5-dicarboxylate; 3-mercaptopropanesulfonic acid sodium salt; 3-mercaptopropanesulfonic acid; bis (2-mercptoethyl) sulfide; ethylene trithio carbonate; ethanethiol; 2-mercptoethanol; monothioglycerol (1-thioglycerol); 1,2-ethanedithiol; and thiодиethanol.

25. (previously presented) The method as claimed in claim 24 wherein said water-soluble, mercapto-containing organic brightener is selected from the group consisting of ammonium diethyldithiocarbamate, 3-mercaptopropanesulfonic acid sodium salt, and 3-mercaptopropanesulfonic acid.

28. (currently amended) The method as claimed in claim ~~24~~ 25 wherein said organic compound is selected from the group consisting of poly[(bis (2-chloroethyl)ether-alt-1,3-bis [3-(dimethylamino)propyl]urea, quaternized, and poly (diallyldimethylammonium chloride).

33. (previously presented) The method as claimed in claim 21 further comprising a brightener/carrier molecule.

34. (previously presented) The method as claimed in claim 33 wherein said brightener/carrier molecule is polymeric protein.

35. (previously presented) The method as claimed in claim 21 further comprising a carrier/leveler molecule.

36. (previously presented) The method as claimed in claim 35 wherein said carrier/leveler molecule is selected from the group consisting of poly[bis(2-chloroethyl/ether-alt-1,3-bis[3-(dimethylamino)propyl]urea, quaternized, and poly(melamine-co-formaldehyde).

37. (previously presented) The method as claimed in claim 21 further adding at least one of an alkaline source compound and a chloride ion-containing compound.

38. (previously presented) The method as claimed in claim 21 wherein said carrier is present in a range of about 2 to 1000 parts per million, said leveler is present in a range of about 2 to 1000 parts per million and said brightener is present in a range of about 5 to 100 parts per million.

39. (currently amended) A method for copper plating of advanced interconnects comprising immersing said interconnects in a copper plating bath comprising an aqueous solution of an acid and a copper salt and at least one of a carrier compound; a water-soluble, mercapto-containing organic brightener compound; and a leveler compound containing single or multiply positively charged centers; wherein said leveler compound is selected from the group consisting of ~~polyethylenimine, 80% ethoxylated~~; poly(allylamine); poly(allylamine hydrochloride); polyaniline, sulfonated, 5 wt. % in water, 75 mole % sulfonated; poly[bis(2-chloroethyl)ether-alt-1,3-bis[3-(dimethylamino)propyl]urea, quaternized; poly[N,N'-bis(2,2,6,6-tetramethyl-4-piperidinyl)-1,6-hexanediamine-co-2,4-dichloro-6-morpholino-1,3,5-triazine; polyacrylamide; poly(acrylamide-co-diallyldimethylammonium chloride); poly(diallyldimethylammonium chloride); poly(melamine-co-formaldehyde), partially methylated; poly(4-vinylpyridine), 25% cross-linked; and poly(1,2-dihydro-2,2,4-trimethylquinoline).

40. (previously presented) The method as claimed in claim 39 wherein said acid is sulfuric acid.

41. (previously presented) The method as claimed in claim 39 wherein said copper salt is selected from the group consisting of copper sulfate, copper acetate, copper fluoborate, cupric nitrate and copper pyrophosphate.

42. (previously presented) The method as claimed in claim 41 wherein said copper salt is copper sulfate.

43. (previously presented) The method as claimed in claim 39 wherein said carrier compound is selected from the group consisting of a polysaccharide compound, polyethylene glycol and poly(ethylene oxide).

44. (previously presented) The method as claimed in claim 43 wherein said polysaccharide carrier compound is selected from the group consisting of starch, cellulose, amylopectin and amylose.

45. (previously presented) The method as claimed in claim 39 wherein said water-soluble, mercapto-containing organic brightener is selected from the group consisting of *N*-methylallyl-*N'*-methylthiourea; tetramethylthiuram disulfide; ethylethylthiomethyl sulfoxide; ammonium diethyldithiocarbamate; dimethyl-2-thioxo-1,3-dithiole-4,5-dicarboxylate; 3-mercaptopropanesulfonic acid sodium salt; 3-mercaptopropanesulfonic acid; bis (2-mercaptoproethyl) sulfide; ethylene trithio carbonate; ethanethiol; 2-mercaproethanol; monothioglycerol (1-thioglycerol); 1,2-ethanedithiol; and thiodiethanol.

46. (previously presented) The method as claimed in claim 45 wherein said water-soluble, mercapto-containing organic brightener is selected from the group consisting of ammonium diethyldithiocarbamate, 3-mercaptopropanesulfonic acid sodium salt, and 3-mercaptopropanesulfonic acid.

49. (currently amended) The method as claimed in claim 47 46 wherein said leveler compound is selected from the group consisting of poly[(bis(2-chloroethyl)ether-alt-1,2-bis[3-(dimethylamino)propyl]urea, quaternized, and poly(diallyl dimethylammonium chloride).

54. (previously presented) The method as claimed in claim 39 further comprising a brightener/carrier molecule.

55. (previously presented) The method as claimed in claim 54 wherein said brightener/carrier molecule is polymeric protein.

56. (previously presented) The method as claimed in claim 39 further comprising a carrier/leveler molecule.

57. (previously presented) The method as claimed in claim 56 wherein said carrier/leveler molecule is selected from the group consisting of poly[bis(2-chloroethyl)ether-alt-1,3-bis[3-(dimethylamino)propyl] urea, quaternized, and poly(melamine-co-formaldehyde).

58. (previously presented) The method as claimed in claim 39 wherein said carrier is present in the composition in an amount ranging from about 2 to about 1000 parts per million parts water.

59. (previously presented) The method as claimed in claim 39 wherein said leveler is present in the composition in an amount ranging from about 2 to about 1000 parts per million parts water.

60. (previously presented) The method as claimed in claim 39 wherein said brightener is present in the composition in an amount ranging from about 5 to about 100 parts per million parts water.

61. (previously presented) The method as claimed in claim 39 wherein said carrier/brightener is present in an amount ranging from about 5 to about 1000 parts per million parts water and said carrier/leveler is present in an amount ranging from about 2 to about 1000 parts per million parts water.

62. (previously presented) The method as claimed in claim 39 wherein said compounds are added either individually or as combinations to said aqueous solution.

63. (previously presented) The method as claimed in claim 39 wherein a current between 3 mA/cm<sup>2</sup> and 40 mA/cm<sup>2</sup> is applied to said solution.

64. (previously presented) The method as claimed in claim 63 wherein the wave form of said current is selected from the group consisting of direct current, pulse current and pulse reverse current.